the retina of the developed eye is a consequence of the similar relation of the stalk to the cup in the embryo.

When the hemispheres commence to develop, it is not until the end of the fourth week that they are at all divided into right and left, and the first indication of division is, curiously enough, a longitudinal ridge in the parietal region. A careful description of the development of the forebrain region, including the plexuses, *corpus striatum*, and the divisions of the interbrain, finally brings the author to a description of the olfactory region. The condition in the embryo is prefaced by a study of the region in the adult. Starting here from the bulb, and passing caudad, the olfactory tract splits into a median and lateral root. These first enclose the *trigonum*. Caudad of this, and separated from it by the *fissura prima*, is a roughly quadrilateral field, a portion of the anterior perforated space, which is bounded laterally by the lateral root of the tract, and mesally by the *gyrus subcallosus* (peduncle of the callosum). This region is the quadrilateral space of Broca. There is another small region lying in the mesal surface, and bounded by the *fissura prima* caudad and the *fissura serotina* frontad, and this His names "Broca's region." In discussing the olfactory lobe in the embryo, His divides it into a cephalic and caudal portion. The cephalic lobe in man gives rise to the bulbus, tractus, trigonum and Broca's field—to the caudal lobe belongs the *gyrus subcallosus* and the quadrilateral space. Where the bulbus comes to overlie the nose region, there is developed over a region of thickened nasal epithelium a true olfactory ganglion, consisting of bipolar nerve-cells, such as are found in the posterior root ganglia of the spinal cord. This ganglion appears first in embryos about 11 mm. in length. In the adult, the ganglion contributes the fiber and glomerular layers, the other portions of the bulbus being an outgrowth from the brain. This discovery, which brings the olfactory nerve in man into line with the typical sensory nerves, is a most welcome one, but the retina still remains, according to His, as much of a problem as ever. For the many other points of value, the reader is referred to the original.

Recherches sur les terminaisons des nerfs dans les disques terminaux chez la grenouille (Rana esculenta, Rana temporaria). J. FAJERSZTAJN. Arch. de zool. exp. et gen., 2d série, T. VII, 1889, p. 705—750, pls. XXXIII et XXXIV.

The author discusses at great length the conflicting results and opinions of Waller, Leydig, Billroth, Fixsen, Hoyer, Key, Hartmann, Engelmann, Merkel, Krause, and Holl. The memoirs of Beale and Maddox, on the arrangement of the nerves in the papillæ of the frog's tongue, were inaccessible to him. For fixing agents, in the present investigation, the best results were obtained with bichloride of mercury (5 to 100), Flemming's solution, and Carnoy's solution. The hardened tissues were imbedded in paraffin and in celloidin, preference being given to the latter. The cells of the disc were teased in a mixture of bichromate of potassium 4 to 100 + 1 to 100 of hydrate of chloral. A weak solution of eosin and iodine-green stained the cell nuclei green and the plasma of the cells red. For coloring the nerve terminations methylene blue, injected into the living animal according to Ehrlich's method, was mainly employed. Near the summit of the fungiform papillæ, and just beneath the end-discs is a "basal membrane," the *Nervenschale* of Key, *Nervenkissen* of Engelmann. Fajersztajn describes four kinds of cells in the end-discs, viz.: cylinder, winged, forked, and staff-shaped. The cylinder cells (*Cylinderzellen*, Merkel, Schwalbe, Holl) correspond to Key's modified epithelial cells, Engelmann's *Kelchzellen*, and Leydig's *Geschmackszellen*. Their central processes are very irregular and most difficult to follow. They reach the basal membrane, where they appear

to intersect with the processes of the other cells. The winged cells (*Flügelzellen*, Merkel) have only been found in batrachians. Leydig mistook them for cylinder cells, while Merkel looked upon them as merely representing a stage in the development of those cells. Their central processes pass between the cells of the disc and pierce the basal membrane. The forked cells (*Gabelzellen*, Engelmann), considered by Merkel artificial products, were found but rarely. They possess very long, varicose central processes, there being always two to four of these processes to a cell. The processes perforate the basal membrane, where they ramify freely and form a plexus with the central processes of the winged and staff cells. Two forms of staff cells are described. The first form corresponds to Key's *Geschmackszellen*, Engelmann's *Cylinderzellen*, and Merkel's *Stützzellen*. The second form is marked by a very short central process. These cells are doubtless Merkel's *Stäbchenzellen*, although no cilia were detected on their free extremity. Merkel looked upon these cells as constituting the sensory elements of the disc. Fajersztajn, however, does not so regard them. He agrees with Engelmann in considering the forked cells as the true sensory cells; but as to whether they are specifically gustative or specifically tactile he does not venture an opinion. Beneath the basal membrane is a plexus formed of non-medullated nerve-fibrils, which the author terms the "*plexus subbasalis*." From this plexus fine varicose fibrils enter the basal membrane, where they ramify in all directions. Some of these fibrils traverse the membrane and penetrate the epithelium, forming beneath the bed of nuclei of the staff cells an exceedingly compact network. From this subepithelial network very delicate varicose fibrils pass between the cells of the disc and reach its free surface, where they terminate in bud-like enlargements. Where and how the fibrils terminate which do not reach the free surface of the disc Fajersztajn is unable to say. He believed in the contiguity, but not in the direct continuity, of nerve-fibrils and the central processes of the sensory cells. Contiguity, he suggests, may be effected either by the terminal buds applying themselves to the bodies of the sensory cells, or by the central processes of those cells adhering closely to the nerve-fibrils of the subepithelial plexus. F. T.

Within a short time the writer of the present note published the results of some studies touching the development of the gustatory organs of man, and at the same time offered a few suggestions as to the nature and probable mode of origin of these terminal structures. (*Journ. Anat. Phys.*, xxiii, 1889, pp. 559–582; xxiv, 1889, pp. 130, 131.) The earliest tongue investigated was from an embryo of about the tenth week. In this specimen the gustatory papillæ were wholly undeveloped, nor was it possible to determine with any degree of certainty their future position. In the next tongue examined, that of an embryo of the fourteenth week, the dorsal surface was more or less marked by papillary elevations of the mucous membrane. The elevations varied greatly in size and shape, and the spaces between them were filled for the most part with epithelium. The epithelial covering of the elevations had an average thickness of about 0.024 mm., and was composed of three somewhat indistinct layer. The superficial layer consisted of slightly flattened cells, which, at its deeper part, became blended with those of the middle layers. The middle layer was much thicker than the preceding, and was composed of nucleated spheroidal or polyhedral cells. Below this was a deep layer consisting usually of a single row of columnar cells. The mucosa was very rich in nuclei, and, at short intervals, was penetrated to a considerable depth by the proliferations of the epithelium. These proliferations of the epithelium are of interest, as indicating the future position of the glands and their ducts.

The striped muscle-fibres of the tongue were clearly shown, but their striæ were exceedingly faint. Several papillæ of the circumvallate type, in the early stages of development, were present. The trenches, however, were undifferentiated, although their future position was clearly indicated. Fungiform papillæ, in various stages of growth, were scattered over the dorsum, and at the sides of the back of the tongue the lateral gustatory organs were sufficiently advanced to be perceptible. A few taste-bulbs were detected in the circumvallate papillæ of this embryo, but, unfortunately, little could be learned of their structural details. The best marked bulb was spheroidal in shape, and resembled, in some degree, those of the soft palate and epiglottis. It was placed vertically in the long axis of the papilla, with its lower two thirds resting in a cavity of the mucosa. On the tongue of a fœtus, at the fourth month of intra-uterine life, were five papillæ of the circumvallate type. One of the smaller of these papillæ bore on its exposed surface a taste-bulb in an early stage of development. This bulb measured 0.0165 mm. in length, and 0.012 mm. in breadth, and was largely subepithelial in position. The tongue of a fœtus at the middle of the fifth month showed circumvallate papillæ in process of transition from the fungiform type. The greater number of the circumvallate papillæ, and also many of the fungiform papillæ bore embryonic bulbs on their upper surface. The more advanced among them were mainly epithelial in position, while the less mature were largely imbedded in the stroma of the mucosa. Medullated nerves were fairly shown in these papillæ. Directly beneath the basal cells of the epithelium was a fine, delicate, reticulated network, from which non-medullated nerve-fibrils passed upwards, penetrating the bulbs and neighboring epithelium. On the tongue of a six months' fœtus the trenches of the papillæ were for the most part differentiated, and a few immature bulbs were detected on their lateral area. In the lateral organs of taste the furrows were quite free from epithelium, save at their lower part, and bulbs were scattered over the upper surface and sides of the folds. In a fœtus at the seventh month, the bulbs had increased greatly on the lateral area of the gustatory papillæ, and there was no apparent decrease in the number of those on the free surface. In a child about a month old the bulbs were quite uniformly disposed at the sides of the papillæ, those of the lower tiers being less regular in arrangement and smaller, and lying partly in the mucosa. In a child four months old, isolated bulbs still occurred on the free upper surface of the papillæ of both gustatory areas. In the circumvallate papillæ of the adult, the bulbs did not appear to have decreased in number, but they had disappeared almost completely from the upper surface. In the adult papillæ foliatæ they were far less numerous than in early life, but were still normally present on the upper area of the folds.

What purpose the temporary taste-bulbs (for such they appear to be) of the free upper surface of the circumvallate papillæ subserve in the embryo, is difficult to comprehend. With the appearance of the bulbs of the lateral area, they gradually disappear, and, from all indications, perish. By the time the bulbs of the free surface of the papillæ have attained their full development, bulbs in early stages of formation make their appearance on the wall, the lowermost bulbs being the most elementary. Were it otherwise, it might be conceivable, as Hermann suggests, that by an unfolding of the papillæ laterally, the bulbs of the free area are shifted to the sides. In the present state of our knowledge, there seems to be no better way than to believe, with Hoffmann, that "the bulbs of the free surface perish through the proliferation of the ordinary epithelium." It is not improbable that, after the bulbs have once disappeared from the upper surface, certain altered condi-

tions of the epithelium prevent, save in rare instances, their recurrence there.

Before concluding this brief summary, the earlier investigations of Hönigschmied, Hoffmann and Lustig should be mentioned. Hönigschmied, in a communication on the microscopic anatomy of the taste-organs (*Zeit. f. wiss. Zool.*, xxiii, 1873), merely remarks that he failed to detect in the circumvallate papillæ of the new-born child any regular arrangement of the bulbs. Hoffmann (*Virchow's Archiv*, lxii, 1875) investigated the human embryo and new-born child for the purpose of studying the distribution of the taste-organs in man. In a fungiform papilla of a four and one half months' fœtus, and also in the papillæ of one at the sixth month, he found taste-bulbs, but he failed to detect them in earlier embryos. He concludes that they are more frequent in embryos and in newly-born than in older individuals; that in embryos and new-born children they occur more frequently and in greater number on the free surface of the papillæ than in the adult, and that in old persons they are but rarely met with in this region. Lustig (*Sitzb. d. k. Akad. d. Wiss. Wien*, lxxxix, iii, 1884) failed to detect bulbs in the papillæ of a fœtus at the end of the fifth month, but in one at the seventh he found them on the free upper surface of both circumvallate and foliate papillæ. While taste-bulbs were wanting in the tongue of a ten weeks' embryo, it is not improbable that they may yet be found in the incipient stages of growth in one of the twelfth week of intra-uterine life.

F. TUCKERMAN.

II.—EXPERIMENTAL.

Ueber die Theorie des simultanen Contrastes von Helmholtz. E. HERING. Four papers in Pflüger's Archiv, Vols. 40, 41, 43.

I. *Die farbigen Schatten.* Helmholtz considers that the experiments with colored shadows show conclusively the influence of the judgment in producing simultaneous contrast. Hering, by more careful experiments, makes it plain that this is not the case. He makes the usual arrangement for colored shadows, the sources of light being day-light and a gas-flame, and the tube being arranged so that it can be instantaneously split open. The tube is so directed that the observer looks half upon the gas-lighted paper and half upon the blue shadow, complete fixation being made easy by a dot in the middle of the line of separation. To facilitate reference we shall call the shadow half of this field *s*, and the gas-lighted half we shall call *g*. After everything is in position, the gas is lighted, and *s* instantly becomes blue and *g* yellow, the yellow being an objective color and the blue subjective. Whether that subjective blue is physiological (in the retina) or psychological (in the judgment) is the question at issue.

The next step in the experiment is to move the shadow-throwing prism so that the tube looks wholly upon its shadow. Under these circumstances, according to Helmholtz, the whole field of the tube is blue, and this shows that the effect is due to the judgment; what one has just judged to be blue one still judges to be blue, and other reason for seeing this blue there is none. But as matter of fact, if the fixation has been careful, *it is not true* that the whole field of the tube is now blue; on the contrary, *g* is blue, but *s* is a distinct grayish-yellow. The blueness of *g* is now easily accounted for,—it is simply the complementary fatigue-color to the former yellow gas-light. Hence there is no occasion to say anything about the persistence of the judgment-error. But what is the cause of the yellowness of *s*? If the former blueness of *s* was physiological—a spreading over of the yellow-excitation, as Hering believes—then it, too, is due to fatigue. But it is still possible